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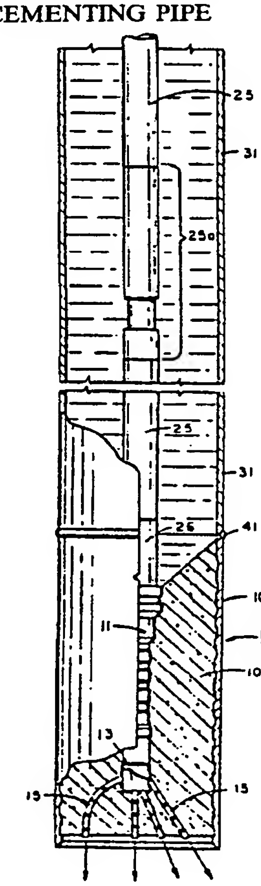
(54) Title: METHOD AND APPARATUS FOR RUNNING AND CEMENTING PIPE

(57) Abstract

A jet shoe (10) is connected to the lowermost end of a pipe (31) to be placed in a subsea formation. The jet shoe comprises a cylindrical housing (10a) in which is arranged an inner tubular receptacle (11), a check valve (18) permitting downward flow but preventing upward flow through the valve and jet tubes (15) extending from receptacle (11) through the lower end of jet shoe (10). Receptacle (10), valve (18) and tubes (15) are cemented in housing (10a). Tubes (15) contain nozzles (16) for jetting fluid to erode formation ahead of shoe (10). A stinger (27) arranged on the lower end of a smaller diameter pipe (25) extends into and seals in receptacle (11). A closure member (35) on smaller pipe (25) releasably closes off the upper end of larger pipe (31). The smaller pipe (25) and the attached larger pipe (31), together with a permanent guide base (45) connected to the upper end of larger pipe (31), are lowered to the ocean floor. While jetting fluid through smaller pipe (25) and out shoe (10), the formation ahead of the shoe (10) is eroded until larger pipe (31) reaches a predetermined depth. Cement slurry (50) is then pumped downwardly through smaller pipe (25) and through jet shoe (10) to cement larger pipe (31) in the subsea formation. If desired, a pressure measuring means (40, 42) may be provided to determine whether any leaks have occurred in the drill pipe. The invention has particular application in locations where the subsea formations are unstable and in locations where it is advantageous to eliminate running of a temporary guide base in offshore operations.



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METHOD AND APPARATUS FOR RUNNING AND CEMENTING PIPE

Technical Field

The present invention concerns running and cementing pipe in subsea formations and, in particular, running and cementing in the subsea floor the first pipe string (structural pipe) run in an offshore well drilling operation.

Background Art

In conventional methods for running structural casing in offshore drilling operations, a temporary guide base is lowered on guide lines from the surface of the water and placed on the ocean floor. An opening through the center of the guide base is positioned over the site of the well to be drilled and serves as a re-entry means to the well site. A string of drill pipe having a drill bit on the lower end thereof is then lowered through the opening in the guide base and a hole is drilled into the ocean floor to the setting depth of the structural pipe string. The guide lines are used to guide the drill string to the opening in the guide base. The drill pipe is removed from the drilled hole to the water's surface. Structural casing is then lowered through the opening in the temporary guide base and into the drilled hole, guided by the guide lines, on drill pipe by means of a suitable running tool connected to the lower end of the

drill pipe and releasably connected to the structural casing. A permanent guide base is attached to the upper end of the casing pipe. Once the structural casing has been set it is cemented in place. The running tool is released from the structural casing string and removed along with the drill string to the water's surface.

In a location that has a soft unstable, unconsolidated ocean floor the temporary guide base may settle below the ocean floor rendering it useless as a re-entry means. For this reason and also, because of other problems such as, severe hole instability and loss of drilling fluid (used to control formation pressure and to clean and stabilize the well bore) into the formation, this method for running and cementing structural casing strings is not satisfactory in such locations.

The present invention overcomes these problems by allowing the structural casing string to be cemented in place prior to releasing it from the drill pipe running string thereby eliminating the need for drilling a hole prior to running the structural casing string. Further, the invention eliminates the need for running a temporary guide base. This feature makes this invention also advantageous for use in normal, firm bottom water locations. Considerable rig time is saved by eliminating the running of a temporary guide base when running pipe in either type location.

Disclosure of Invention

The apparatus for running and setting large diameter (structural) pipe in accordance with the invention includes a jet shoe which is connected into the end of the large pipe. The shoe comprises a cylindrical member which contains an inner receptacle provided with an upper seat, a polished bore, a check valve and a chamber. A plurality of open-ended jet

tubes connect to the chamber at their upper ends and extend to the lower end of the shoe at their lower ends. Nozzles are located in the ends of the tubes which are arranged to facilitate washing formation away from in front of the shoe to form the hole for the large pipe. The receptacle and the tubes are cemented in place in the shoe with the upper end of the receptacle and the lower end of the tubes forming continuous flow paths through the valve.

A stinger sub is connected to the lower end of a smaller diameter (drill) pipe. The stinger contains seals, is insertable into the receptacle and seals off against the polished bore of the receptacle. The smaller pipe also contains a closure member which releasably and sealingly engages the upper end of the larger pipe string. A permanent guide base is also connected to the upper end of the larger pipe string. The smaller pipe also contains a bumper sub, a telescoping section, for spacing-out purposes. The closure member may be provided with an opening to which a hose is connected for measuring at the surface pressures within the larger pipe.

The method in accordance with the invention includes the steps of lowering the larger pipe string on the smaller pipe string from the water's surface to the ocean floor and pumping fluid through the smaller pipe string and out through the jet shoe connected to the lower end of the larger pipe string while lowering the pipe strings until the predetermined setting depth for the larger pipe string is reached. Cement slurry is then pumped through the smaller pipe string and the jet shoe to cement the larger pipe string in place. The smaller pipe string is then disconnected from the upper end of the larger pipe string and removed to the water's surface.

Brief Description of Drawings

Fig. 1 is a vertical, partly sectional view of the jet shoe of the invention;

Fig. 2 is a view taken along lines 2-2 of Fig. 1;

Fig. 3 is a vertical, partly sectional view illustrating the stinger portion of a drill pipe sub positioned in the receptacle of the jet shoe;

Fig. 4 is a sectional view illustrating the nozzle end of one of the jet tubes;

Fig. 5 is a plan view of the uppermost end of the structural casing;

Fig. 6 is a view taken along lines 6-6 of Fig. 5;

Fig. 7 is a plan view of the closure member mounted on the drill string;

Fig. 8 is a view taken along lines 8-8 of Fig. 7;

Fig. 9 is a vertical, partly sectional view of the structural casing, jet shoe and the arrangement of the drill pipe and stinger in the structural casing and jet shoe;

Fig. 9A is a vertical cross-sectional view of the uppermost end of the structural casing showing the drill pipe and closure member arranged within the structural casing and a permanent guide base attached to the upper end of the structural casing; and

Figs. 10, 11 and 12 illustrate the steps of running and cementing the structural casing in the ocean floor.

Best Mode For Carrying Out The Invention

Figs. 1 and 2 illustrate a jet shoe 10 formed by cylindrical housing 10a which contains an inner centrally located tubular receptacle 11, the inside diameter of which forms a polished bore 12. The upper end of receptacle 11 forms a seat 12a. The lowermost end of receptacle 11 forms an outlet chamber 13 containing openings 14 to each of which is

connected a jet tube 15. The tubes are preferably arranged in a concentric ring pattern. The tubular receptacle and tubes are maintained in place by cement 10b. Three of the outer ring tubes 15a are curved to a vertical end and three of the outer ring tubes 15b extend at an angle. They are alternately positioned as shown in Fig. 2. The three inner ring tubes 15c extend at an angle and the center tube 15d extends vertically. As seen in Fig. 4, each jet tube 15 contains a nozzle 16 which is insertable and held in place by a snap ring 17. Receptacle 11 also contains a back pressure ball check valve 18. The ball seats on a seat 19 to close off upward flow of fluids through the valve.

As seen in Fig. 3, the lower end of a drill pipe 25 is threaded into a drill pipe sub 26 which is provided with a stinger 27 shown positioned in receptacle 11. Stinger 27 is provided with a series of spaced-apart seals 28 which seal off against the bore 12 of receptacle 11.

As shown in Figs. 5 and 6 the upper end 30 of a structural casing pipe 31 contains a plurality of J-slots 32 spaced about the inner wall of upper end 30 of the structural casing pipe.

Referring now to Figs. 7 and 8 a closure member 35 includes a cylindrical member 36 containing spaced-apart lugs 37 which are engageable in J-slots 32 of the structural casing pipe. Tubular members 38 and 39 connect into the drill pipe on each side of closure member 36. Tubular members 38 and 39 and bore 36a of member 36 form a continuous passageway. Seals 35a are arranged on the outer surface of closure member 36 for sealing on the inner surface of structural casing 31. An opening 40 may be formed in member 36 to which may be attached a hose or line 42 which extends to the water's surface.

The manner in which jet shoe 10, structural casing 31, drill pipe 25 and closure member 35 are arranged is illustrated in Figs. 9 and 9A. Jet shoe 10 is connected, preferably welded, to the lower end of structural casing 31, as indicated at 41. Drill pipe 25 includes a conventional bumper sub 25a to permit proper spacing out of the drill pipe between closure member 35 and stinger seat 12a. Closure member 35 is connected into the upper end 30 of structural casing 31 and seals 39 seal off the inner surface on that upper end. A permanent guide base, indicated at 45, is mounted on the upper end of casing 31.

Housing 10a may be a thirty inches outside diameter cylinder for use with a thirty inches outside diameter casing pipe 31. The tubes are preferably one and one quarter inches outside diameter. Six of the tubes are positioned on an eighteen inch bow circle at sixty degree spacing. Three of the tubes 15a on the eighteen inch bow circle are vertical and the other three tubes 15b are angled at thirty degrees (A_1) from vertical. Three of the tubes 15c are on a ten inch bow circle at a one hundred and twenty degree spacing. The tenth tube 15d is at the center of the shoe. The three tubes on the ten inch bow circle are angled at twenty degrees (A_2) from vertical. The three tubes on the ten inch bow circle are in line with the three tubes at thirty degrees on the eighteen inch bow circle. The center tube is vertical. The jet nozzles are typical, snap ring type nozzles and are inserted into one and one quarter inch diameter aluminum tubing flow paths. All of the aluminum flow paths are connected to the main flow path of the shoe in chamber 13 at or below the center line of the valve 18. The outlets of the six tube ring are on a nine inch radius R_1 circle. The outlets of the three tube ring are on a five inch radius R_2 circle. The outlet

diameter D_1 of nozzle 16 is preferably one-half inch. All of the internal flow paths for this illustrative embodiment of the invention are rated for at least three thousand psi working pressure. The side of the jet shoe extends approximately two inches below the cement and outer tube ends. When used with a thirty inch outside diameter structural casing the overall length of the shoe may be 59 inches. The cement 10b in the jet shoe is tapered at its upper end to facilitate entry of stinger 27 of the drill pipe. All of the materials in the jet shoe are readily drillable.

In conducting the method for running and cementing-in structural casing string 31 jet shoe 10 is welded to the lowermost joint of the casing string. After all of the casing joints have been connected, the string of drill pipe 25 is run inside the casing string until stinger 27 has been stabbed into receptacle 11 in jet shoe 10. Casing string 31 is kept filled with water to balance hydraulic pressures and prevent collapse of the casing string. Closure member 35 is made up on the top of the casing string 31 by engaging lugs 37 in J-slots 32. Hose 42 connects to opening 40 and extends to the water's surface for monitoring pressure inside casing 31 during jetting to detect possible leaks of drilling fluid through the bumper sub seals and/or seals 28 on stinger 27. Those seals retain pressure in drill string 25 and receptacle 11. Permanent guide base 45 is connected to the top of the casing string 31 and the casing string is lowered on drill pipe 25 to the ocean floor. Guide lines 55 are connected to guide posts 56 which are mounted on guide base 45. The casing string is jetted through the unconsolidated formation sediments by pumping drilling fluid down the drill pipe and through jet nozzles 16 in tubes 15 as shown in Fig. 10. The jet nozzles allow sufficient fluid flow rates

and provide sufficient impact force to erode the formation directly ahead of shoe 10. All mud returns are taken outside of the casing pipe and all jetting pressure is confined to the inside of the drill pipe 25. When casing string 31 reaches total setting depth, cement slurry 50 as indicated in Fig. 11, is pumped down drill pipe string 25 through jet tubes 15 and up around the borehole surrounding casing pipe string 31 to provide sufficient skin friction to hold the casing pipe string in place after it is released from the running drill pipe string. Fig. 12 shows drill pipe string 25 disconnected from the upper end of casing pipe string 31 and in the process of being removed from casing pipe 31.

Significant features of the invention include 1) incorporation of jet nozzles into a pipe shoe; 2) providing means to assure that all pumped and jetted fluid and cement returns are confined to the outside of the pipe string and 3) providing means to jet a pipe string into place, pump cement through it while holding it in place with a running pipe string until the cement develops sufficient compressive strength and permitting release of the running pipe string without the possibility of cementing the running pipe string into the pipe shoe.

The invention eliminates the shallow hole instability problems in soft, unstable ocean floor deep water locations and saves significant amounts of tangible and intangible drilling costs. The invention is applicable in soft bottom, locations with shallow hole instability problems and, in addition, is applicable to normal, firm bottom locations as an alternative to running a temporary guide base. Eliminating the temporary guide base saves rig time.

While the invention has been described and illustrated with respect to running and cementing well

pipe and, particularly, structural casing pipe it has other applications, as for example, it may be used in running and cementing pipe used as subsea pilings. Also, other tube patterns may be employed. For example, seven tubes, instead of ten tubes, may be used in which six outer tubes are on an eighteen inch bow circle and are angled to provide internal flow paths at forty five degrees from vertical. The seventh tube is a vertical center tube.

Changes and modifications may be made in the specific illustrative embodiments of the invention shown and described herein without departing from the scope of the invention as defined in the appended claims.

Having fully described the apparatus, method of operation, objects and advantages of my invention, I claim:

Claims

1. Apparatus for use in running and cementing larger diameter pipe in subsea formations comprising:

a cylindrical housing containing an open ended receptacle extending from one end of said housing into said receptacle, a valve arranged at the interior end of said receptacle permitting flow of fluids in only one direction through said valve, and a plurality of tubes forming flow paths extending from said valve to the other end of said housing, said tubes containing nozzles for jetting fluid therefrom.

2. Apparatus as recited in claim 1 including a smaller diameter pipe extending from the water's surface into said larger pipe and having a stinger for insertion into said receptacle, said stinger containing seal means for sealing off the outer surface of said stinger and the inner surface of said receptacle; and

closure means on said smaller pipe for closing off the upper end of said larger pipe.

3. Apparatus as recited in claim 2 including cement surrounding said receptacle, valve and tubes in said housing.

4. Apparatus as recited in claim 3 in which said tubes extend vertically from said valve, one extending vertically and said other tubes being spaced about said one tube.

5. Apparatus as recited in claim 4 in which ten tubes are arranged in said housing, one being positioned in the center of said housing and the others being positioned in concentric rings about the center tube, six of said tubes being on a bow circle at 60 degree

spacing and three of said tubes being on a 10 degree bow circle at 120 degrees spacing.

6. Apparatus as recited in claim 5 in which said tubes are formed of aluminum.

7. Apparatus as recited in claim 6 in which the outer rim of said housing extends beyond said cement and ends of said tubes.

8. Apparatus as recited in claim 7 in which said larger pipe comprises structural casing pipe and said smaller pipe comprises drill pipe.

9. Apparatus as recited in claim 8 including seal means for sealing said closure means on said casing pipe.

10. Apparatus as recited in claim 9 including pressure monitoring means attached to said casing pipe.

11. Apparatus as recited in claim 10 including a permanent guide base connected to the upper end of said casing pipe.

12. Apparatus as recited in claim 11 including means for releasably connecting said closure means to said casing pipe.

13. Apparatus as recited in claim 12 in which the upper end of said cement is tapered.

14. A method for running and cementing larger diameter pipe in a subsea formation comprising:

lowering said larger pipe on smaller diameter pipe from the water's surface while jetting fluid through said smaller pipe and out the end of a jet shoe cemented

to the end of said larger pipe until said larger pipe has reached a predetermined depth in said formation; and

pumping cement slurry through said smaller pipe and said jet shoe to cement said larger pipe in said formation.

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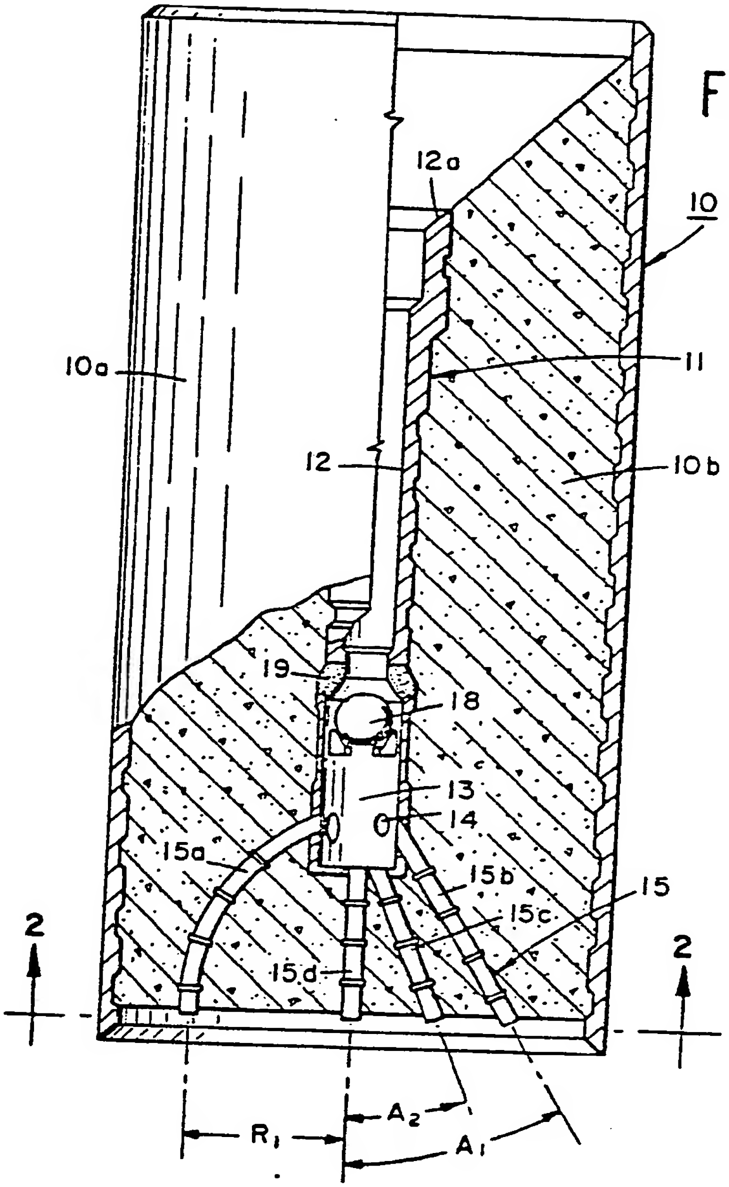


FIG. 1.

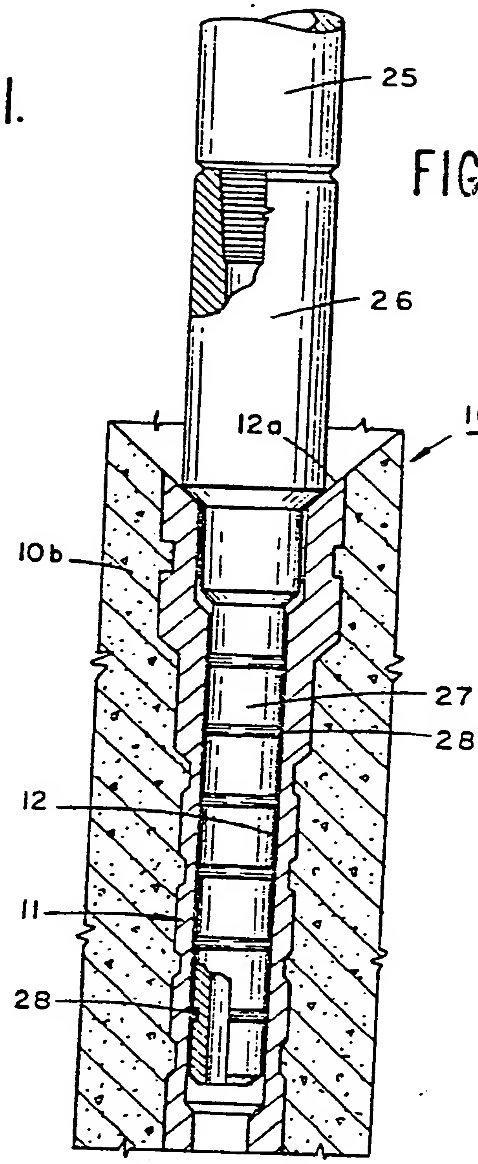


FIG. 3.

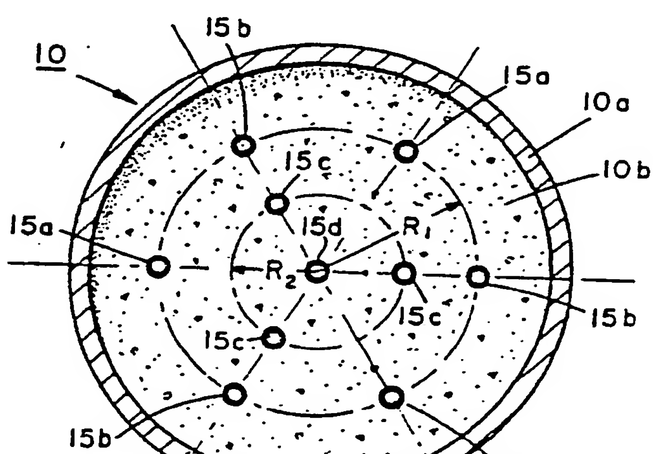


FIG: 2

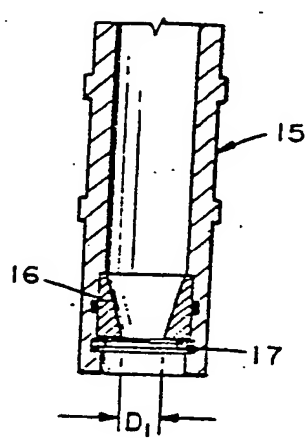


FIG. 4.

FIG. 5.

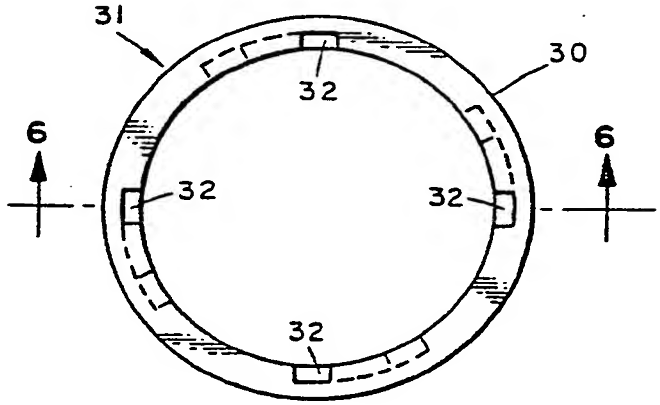
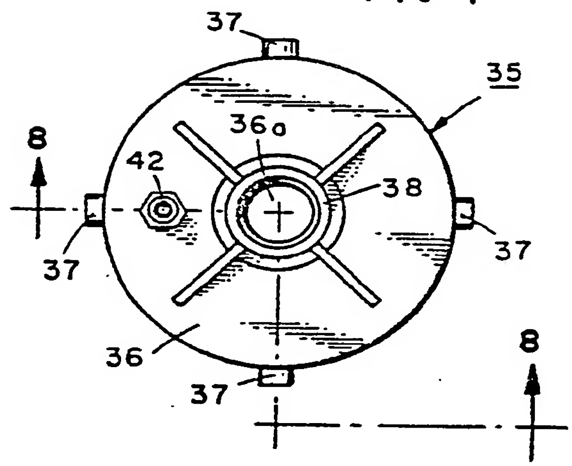


FIG-7.



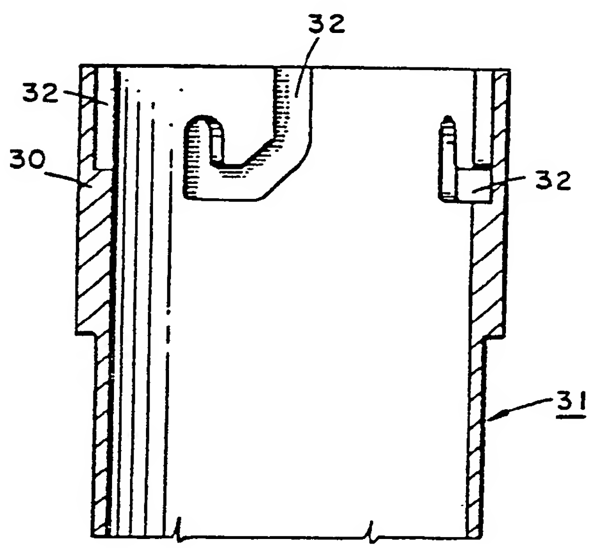


FIG. 6

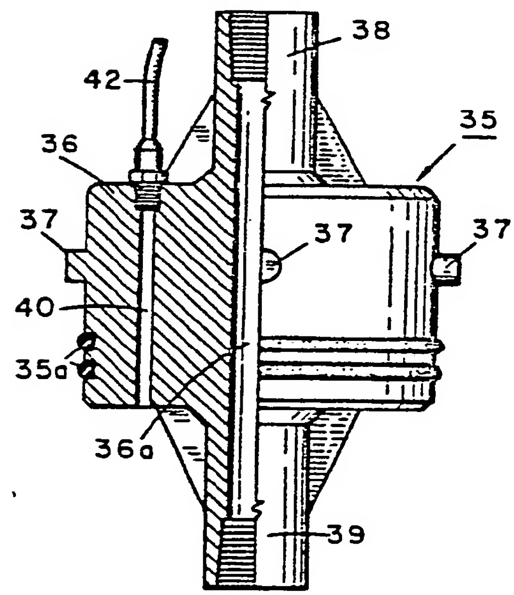


FIG. 8.

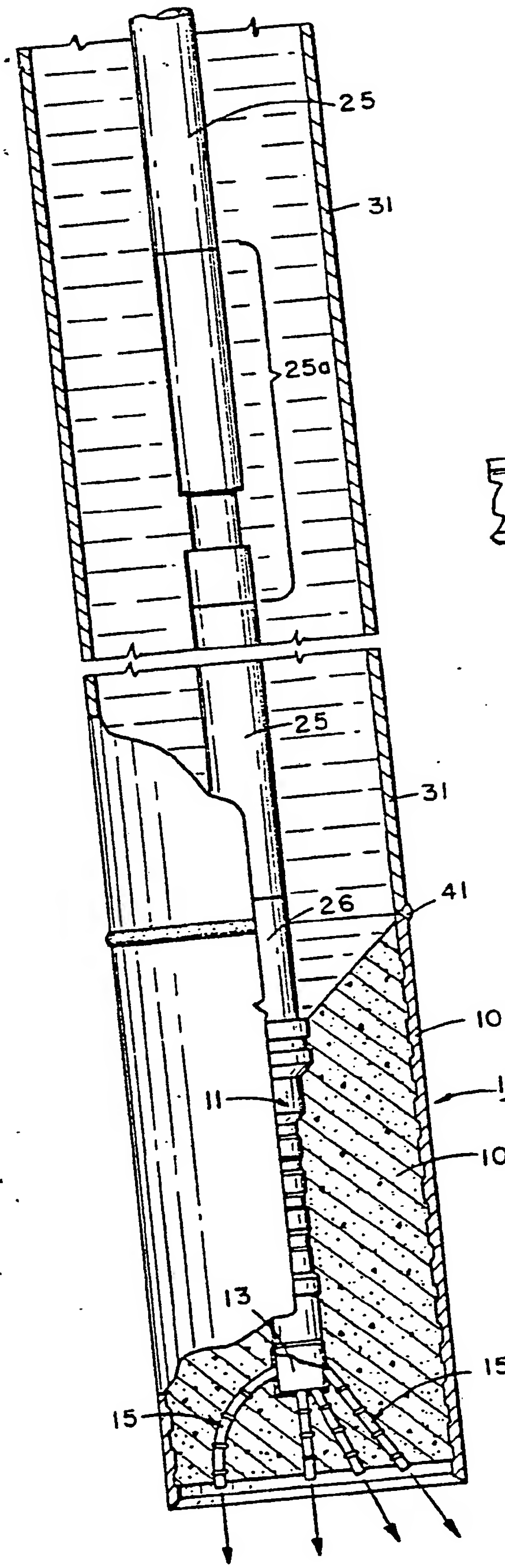


FIG. 9.

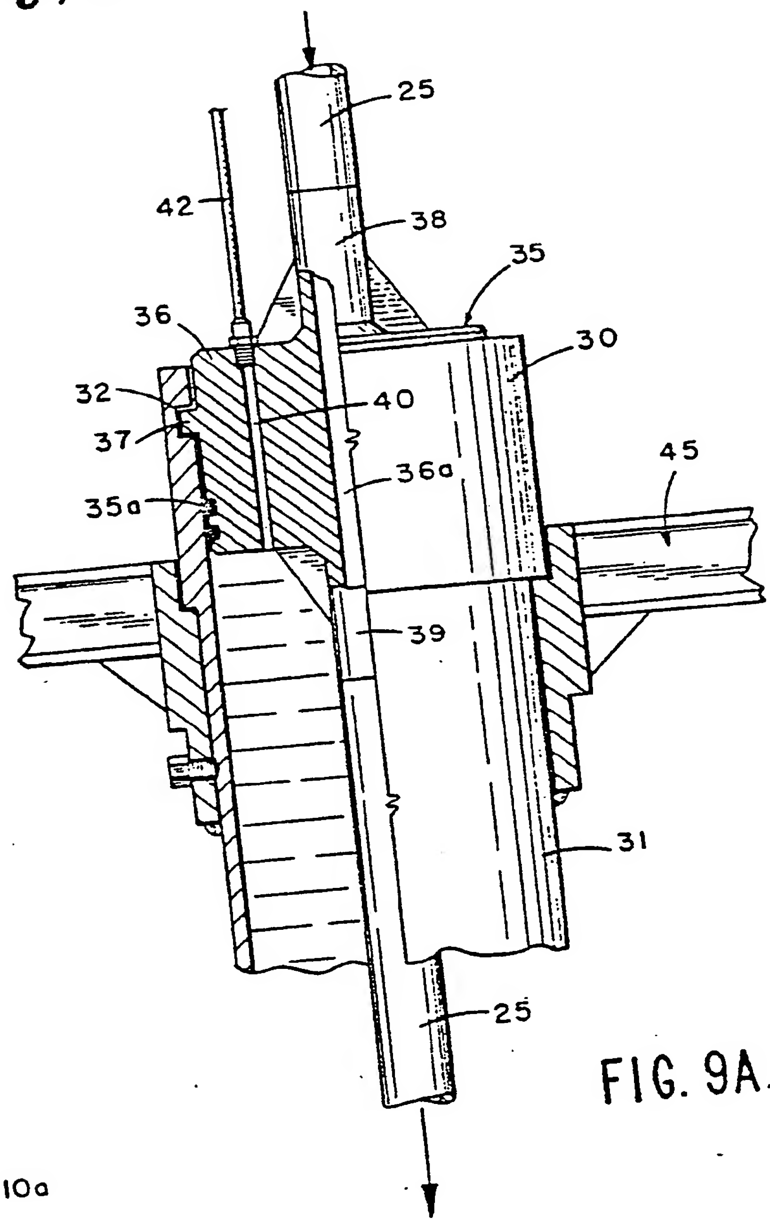


FIG. 9A.

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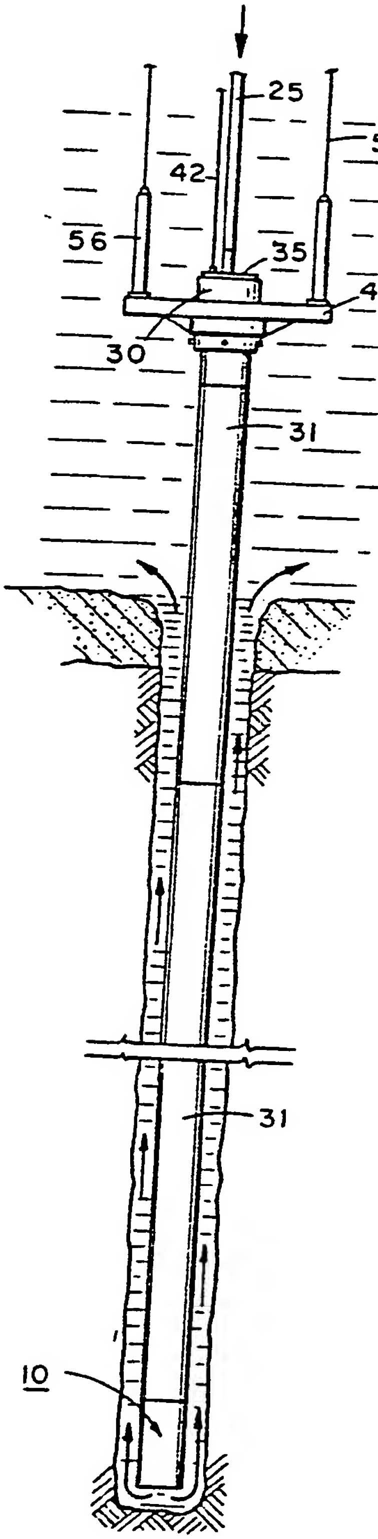

FIG. 10

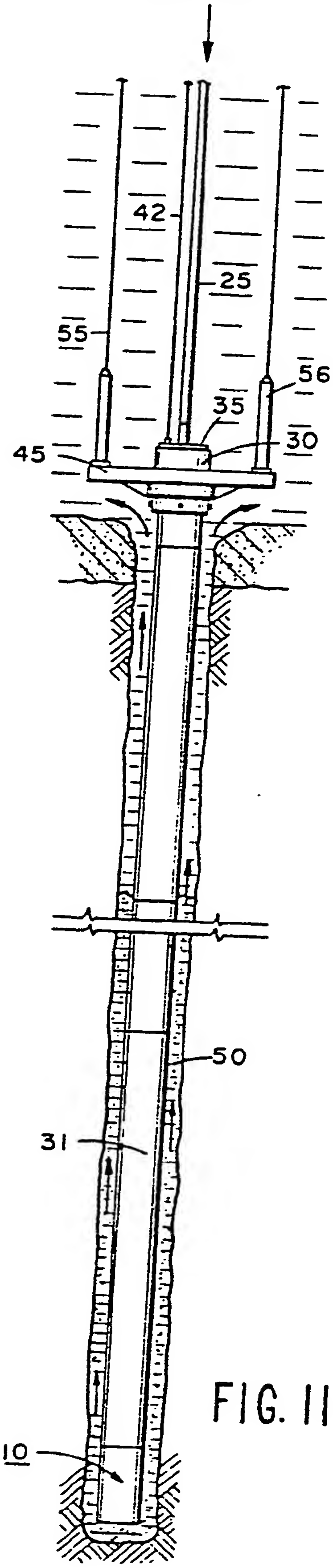

FIG. 11.

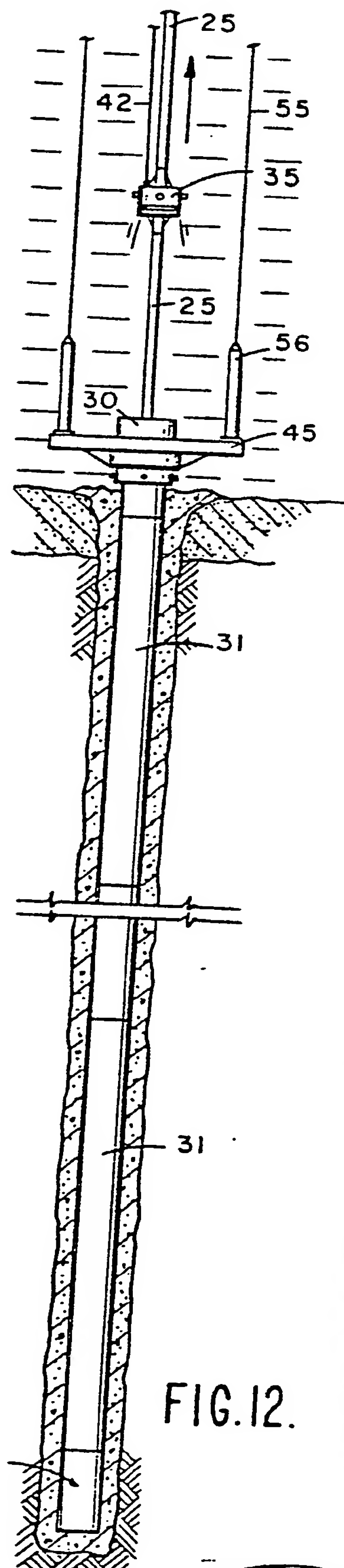

FIG. 12.

INTERNATIONAL SEARCH REPORT

International Application No PCT/US80/01312

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[3] E 21 B 7/18 - E 21 B 33/13
U.S. Cl. 166/290, 175/171, 175/422, 405/248

II. FIELDS SEARCHED

Classification System	Minimum Documentation Searched [4] Classification Symbols
U.S.	175/67, 22, 171, 422 166/285, 290, 157 405/240, 248, 233, 236

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US, A, 340,035, Published Apr. 1886 Douglass	
X	US, A, 1,002,284, Published Sept. 1911 Martin	1-2
X	US, A, 1,831,209, Published Nov. 1931 Thornley et al.	1-2
A	US, A, 2,838,120, Published June 1958 Allmendinger et al.	
A	US, A, 3,086,591, Published Apr. 1963 Sexton	
X	GB, A, 614,591, Published Dec. 1948 Matheson	1,2, &14
A	CA, A, 884,756, Published Nov. 1971 Hoody	
A	DE, A, 324,655, Published Sept. 1920 Siemens	

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"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
13 July 1981	23 JUL 1981
International Searching Authority [1]	**Signature of Authorized Officer [20]**
U.S.	James A. Leppink

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